BACTERIOLOGICAL WATER QUALITY OF OTTER LAKE

by

Allan Burger

Bacteriology Branch
ONTARIO WATER RESOURCES COMMISSION

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Abstract

During the August, 1970 bacterial water quality survey, the bacterial levels in Otter Lake were below the water quality criteria for total body contact recreation. The geometric mean bacterial levels were:

Parameter	Geometric Mean Level
Total Coliform (TC) /100 ml	146
Fecal Coliform (FC) /100 ml	2
Fecal Streptococcus (FS) /100 ml	2

Some natural station to station differences were present but were insufficient to warrant a critical remark.

Canada

Introduction

As part of the 1970 Recreational Lakes Program, a single intensive bacteriological survey was carried out on Otter Lake in the District of Parry Sound. Otter Lake is a stellate-shaped lake which receives water from many small streams and flows to the north-east with the major outflow being the Boyne River. The lake has no towns or villages on its shore but cottage development is extensive in some areas.

Methods

During the period of August 24 to 28, 1970 daily bacteriological samples were taken at forty-four surface stations and three depth stations (20D, 29D and 37D) on Otter Lake (Figure 1). Surface stations were sampled within one meter of the water surface using sterile 250 ml autoclavable polycarbonate bottles. Depth stations were sampled using sterile 237 ml rubber air syringes and a modified "piggy-back" sampler. After taken, the samples were stored on ice until delivery to the nearby mobile laboratory. Within 2 to 7 hours, analysis of all samples was begun for the three bacterial parameters; total coliform (TC), fecal coliform (FC) and fecal streptococcus (FS).

All analyses were by the membrane filtration method as set out in Standard Methods (1) except that MacCorkey membrane broth was used for fecal coliforms.

The results from all analyses were organized as replicates representing the station during the survey period. All data was transformed to the natural logarithm (logarithm to the base e) and all further statistical evaluation was carried out on the transformed data. Initially, geometric means (the antilogarithm of the average of the logarithm data) were calculated for each station and each parameter. Then an analysis of variance or F-test (2) was carried out in order to group stations which were not significantly different one from the other.

The analysis of variance was first performed on all the stations for a given parameter and survey. If some of the stations proved to be significantly different, the data from these stations was removed to a separate grouping. The analysis of variance was then redone until no stations in the group were significantly different. All groups formed by the extraction of stations from the original group were similarly analyzed. A single geometric mean was then calculated for each homogeneous group of stations.

For convenience, all logarithms presented in the tables in this report are in the form of logarithms to the base 10.

Throughout the statistical evaluation of the data, all geometric mean bacterial levels were compared with the water quality criteria for total body contact recreational use as presented by the OWRC (4).

Results and Discussion

The summary of the analysis of variance grouping of stations is presented in Table I. The station locations and the geographic distribution of bacterial levels are presented in Figure 1.

All geometric mean bacterial levels were well below the water quality criteria for total body contact recreation (1,000 TC/100 ml, 100 FC/100 ml and 20 FS/100 ml).

Although the FC and FS levels were significantly different at a few stations on Otter Lake, these differences are not sufficiently out of line with a natural situation to warrant any critical remarks concerning the water quality. The geometric mean bacterial levels at most of the stations can be summarized as 146 TC/100 ml, 2 FC/100 ml and 2 FS/100 ml. Therefore, during the August 1970 survey, the bacterial levels in Otter Lake were below the water quality criteria for total body contact recreation.

References

1) "Standard Methods for the Examination of Water Wastewater", twelfth edition 1965, APHA, AWWA, WPCF.

2) Sokal, R. R. and Rohlf, F. J., 1969. Biometry. The principles and practice of statistics in biological research. W. H. Freeman and Company, San Francisco, 776 pp.

3) Rohlf, F. J. and Sokal, R. R., 1969. Statistical Tables, W. H. Freeman and Company, San Francisco, 252 pp.

4) Ontario Water Resources Commission, June 1970. Guidelines and Criteria for Water Quality Management in Ontario.

TABLE I

Summary of the Analysis of Variance Grouping of Stations

Otter Lake, 1970

Survey: August 24 to 28, 1970

Parameter: Total Coliform (TC)/100 ml

Group	All Stations
F	0.71 df 45, 184
F(5%)	1.39
	NSD
log GM	2.1640
S.E.	0.0223
N	230
GM	146

Parameter: Fecal Coliform (FC)/100 ml

Group	All Stations
F	2.01 df 45, 184
F(5%)	1.39
	SD

Group	1) All Stations except 36, 39, 40 and 41
F	1.25 df 41, 168
F(5%)	1.39
	NSD
log GM	0.3293
S.E.	0.0283
N	210.
GM	2.

TABLE I - (continued)

Parameter:	Fecal Coliform (FC)/100 ml	
Group:	2) Stations 36, 39, 40 and 41	
F	0.25	df 3, 16
F(5%)	3.24	
	NSD	
log GM	0.9390	
S.E.	0.1042	
N	20.	
GM	9.	

Parameter:	Fecal Streptococcus (FS)/100 ml	
Group:	All Stations	
F	1.63	df 45, 184
F(5%)	1.39	
	SD	

Group:	1) All Stations except 20D, 29, 29D, 27 and 41	
F	1.00	df 40, 164
F(5%)	1.39	
	NSD	
log GM	0.3759	
S.E.	0.0280	
N	205.	
GM	2.	

TABLE I - (continued)

Parameter: Fecal Streptococcus (FS)/100 ml

Group:	2) Station 20D, 29 and 29D
log GM	0.0000
S.E.	0.0000
N	15.
GM	1.

Group:	3) Station 27
log GM	0.8179
S.E.	0.1994
N	5.
GM	7.

Group:	4) Station 41
log GM	0.9238
S.E.	0.1516
N	5.
GM	8.

Appendix A

Explanation of Terms in Tables

F — the calculated analysis of variance statistic on F ratio

df — degrees of freedom of the F ratio for "between group" and "within group" variation

F(5%) — the initial F ratio from a statistics table

If the calculated F is greater than the F(5%) a significant difference (SD) occurred between the groups in the analysis. If F is less than F(5%), no significant difference (NSD) occurred.

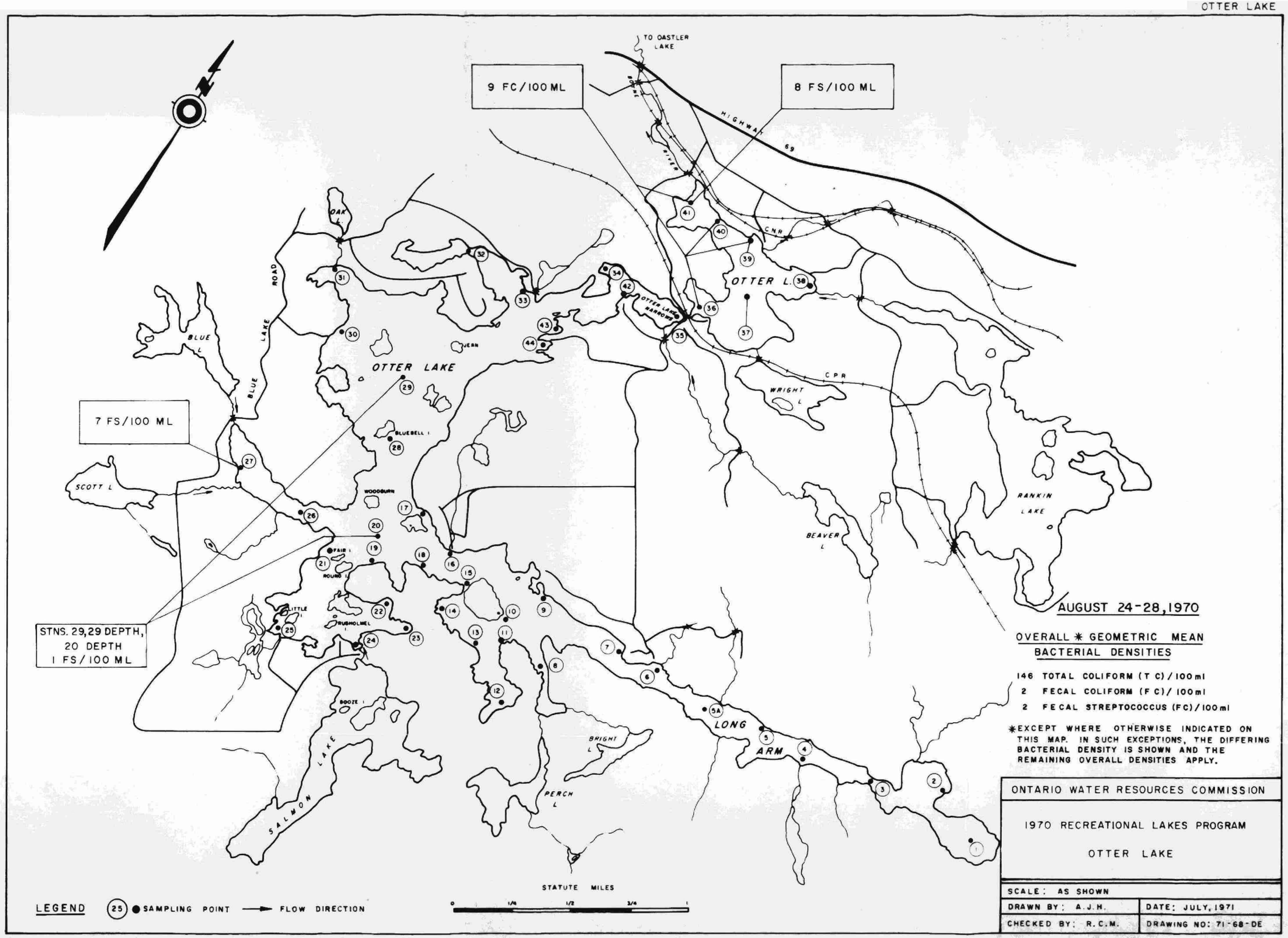
log GM — the logarithm (base 10) of geometric mean for all groups in the analysis of variance when NSD occurred

S.E. — the standard error of the log GM where

$$S.E. = \frac{s}{\sqrt{n}} \quad \text{and} \quad s = \text{standard deviation}$$

N — the number of values in the mean

GM — the geometric mean of the bacterial level


9 FC/100 ML
8 FS/100 ML
7 FS/100 ML
STNS. 29,29 DEPTH,
20 DEPTH
1 FS/100 ML
TO CASTLER LAKE
HIGHWAY 69
C.N.R.
C.P.R.
OTTER L.
OTTER LAKE
OTTER LAKE NARROWS
OAK L.
BLUE L.
BLUE LAKE ROAD
JEAN
BLUEBELL L.
WOODBURN
SCOTT L.
FAIR L.
ROUND L.
LITTLE L.
RUSHOLME L.
BOOZE L.
SALMON LAKE
BRIGHT L.
PERCH L.
WRIGHT L.
LONG ARM
BEAVER L.
RANKIN LAKE
STATUTE MILES
0 1/4 1/2 3/4 1
LEGEND (25) SAMPLING POINT FLOW DIRECTION
AUGUST 24-28, 1970
OVERALL * GEOMETRIC MEAN
BACTERIAL DENSITIES
146 TOTAL COLIFORM (T C)/100 ml
2 FECAL COLIFORM (F C)/100 ml
2 FECAL STREPTOCOCCUS (FC)/100 ml
*EXCEPT WHERE OTHERWISE INDICATED ON THIS MAP. IN SUCH EXCEPTIONS, THE DIFFERING BACTERIAL DENSITY IS SHOWN AND THE REMAINING OVERALL DENSITIES APPLY.
ONTARIO WATER RESOURCES COMMISSION
1970 RECREATIONAL LAKES PROGRAM
OTTER LAKE
SCALE: AS SHOWN
DRAWN BY: A.J.H.
DATE: JULY, 1971
CHECKED BY: R.C.M.
DRAWING NO: 71-68-DE